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STATE DEVELOPMENT PLANNING SERIES

GROUND-WATER AQUIFERS AND MINERAL COMMODITIES OF MARYLAND

MARYLAND STATE PLANNING DEPARTMENT

MARYLAND GEOLOGICAL SURVEY

U.S. DEPARTMENT OF THE INTERIOR-GEOLOGICAL SURVEY

MARY ATT STRART TOOK ROOM UNITED TOO MARKE NO LITTERY SOULDS: PARK A

Wye Oak, pictured on the cover, is the official State tree of Maryland. Located in Wye Mills on Maryland's Eastern Shore, this magnificent white oak is one of the largest in the United States. It was over 100 years old when Leonard Calvert led Maryland's first colonists ashore in March of 1634. Photograph courtesy of Maryland Department of Economic Development.

The Aquifer section of this report was prepared by the U. S. Department of the Interior in cooperation with the Maryland Geological Survey and the Maryland State Planning Department.

The Mineral Commodities section of this report was prepared by the Maryland Geological Survey in cooperation with the Maryland State Planning Department.

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MARYLAND STATE PLANNING DEPARTMENT

STATE OFFICE BUILDING
BALTIMORE, MARYLAND 21201

mongand. State Planning Rept.

GROUND-WATER AQUIFERS AND MINERAL COMMODITIES OF MARYLAND



STATE OF MARYLAND

Marvin Mandel, Governor

Maryland State Planning Department

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Maryland Geological Survey

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STATE OF MARYLAND

PLANNING DEPARTMENT

STATE OFFICE BUILDING

301 W. PRESTON ST

TELEPHONE: 383-3010

DIRECTOR

May 1, 1969

Honorable Marvin Mandel Governor of Maryland The State House Annapolis, Maryland

Dear Governor Mandel:

I am pleased to transmit the enclosed report entitled Groundwater Aquifers and Mineral Commodities of Maryland. This report is another in the series being developed as part of the Statewide Planning Program administered by this Department. The technical aspects of this study were undertaken by the Maryland Geological Survey in cooperation with the Geological Survey, U. S. Department of the Interior.

The aquifer and mineral material presented in this report will be useful for a wide variety of planning activities and information requirements. This document also includes information concerning important non-renewable mineral resources of the State.

It is felt that this study will be useful not only in the Statewide planning process but will also be valuable to many individuals, organizations, agencies, and departments both public and private. Copies of this report are being distributed throughout the State.

Sincerely,

Vladimir Wahbe

Director

INTRODUCTION

The maps contained in this report show the statewide distribution of the significant mineral and ground-water resources of Maryland. The maps were compiled from either published or open-filed data and, therefore, do not represent new geologic data and information. Because the report was designed to provide a rapid, albeit generalized, overview of where the State's natural resources are located, its chief utility is for geographic reference, rather than economic appraisal or engineering design. For example: although one of the maps shows the surface distribution of limestone formations in the State, it does not provide the detailed chemical or mineralogic information needed for commodity decisions. Similarly, the aquifer maps do not comment directly upon questions of water quality or yield at a specific site. Where data permit, the maps do, however, show which aquifers occur beneath an area by giving (in the case of the Coastal Plain) their approximate depth of occurrence. If more specific detail is required, the Maryland Geological Survey or its publications should be consulted.

There are ten aquifer maps. Maps I and II cover the Piedmont and Appalachian regions, occurring west of the Fall Line. The remaining eight maps show the known outcrop and subsurface distribution of the major Coastal Plain aquifers. The mineral commodities of the State are shown on Maps XI through XVI.

The geologically complex rocks of the Piedmont and Appalachian provinces are categorized into three hydrologic units, depending upon their productive capacities. For example, the geologic formations constituting Unit I have approximately a 20 percent chance of yielding 50 gpm (gallons per minute) or more; on the other hand, this probability is reduced to 6 percent and 2 percent in Units II and III respectively. These are, of course, statistical inferences and



provide only a very generalized representation of the water-yielding characteristics of the rocks. Local geologic anomalies can substantially alter these relationships.

The Coastal Plain aquifers occur as a series of irregularly shaped wedges that gently dip, generally less than 1°, to the south and east. The upper truncated edges of these formations outcrop as a series of concentric bands. These are, from west to east, the Patuxent Formation, Patapsco-Raritan (undivided) Formation, Magothy Formation, Aquia Greensand, Piney Point Formation, Manokin Aquifer and Pocomoke Aquifer. The latter two are everywhere buried beneath a surficial mantle of Plio-Pleistocene sands and gravels. Map X is a structure contour map showing the depth to the base of the Plio-Pleistocene sediments. Deep, linear areas on this map represent both recent (Susquehanna and Choptank) and ancestral (near Salisbury and Berlin) river channels; the thick, permeable nature of the latter is highly favorable for large capacity wells.

Except in their outcrop areas, all of the formations shown in Maps III to IX function as artesian aquifers. At the outcrop water-table conditions prevail. Under natural conditions the outcrop belts function as recharge areas in upland localities and discharge areas in lowland localities.

The Piney Point aquifer, which does not outcrop, is recharged by leakage through confining beds. Other major subsurface boundaries of this type are shown on the Aquia and Magothy maps.

The Patuxent and Patapsco-Raritan (undivided) Formations are multiaquifer units. Although boundaries within these formations may be locally important, their complexity prevents a representation at the published map scale.

The six mineral-resource maps illustrate the general areas of occurrence of mineral commodities which are economically important to the State. Specific

localities for mineral-producing operations within these generalized areas are determined by many factors including chemical quality and physical properties of the materials, the topography and ground-water conditions at the site, access to the site and its proximity to a ready market, and the value of the land relative to other uses.

Over 90 percent of the value of mineral production in Maryland is contributed by the production of sand and gravel, crushed stone and cement - materials of basic importance to the building and construction industries.

Sand and gravel which is shown on Map XIII generally is limited to the Coastal Plain with the best deposits occurring along the western edge. On the other hand, Map XI shows that materials suitable for crushed stone are found in the Piedmont and Appalachian regions of central and western Maryland. Carbonate rocks as portrayed on Map XIII represent a special case of crushed stone in which the chemical quality is of more importance than the physical properties for such uses as cement and lime manufacture.

Clays and shales occur throughout the State, ranging from unconsolidated clays in the Coastal Plain to consolidated shales in the Piedmont and Appalachian regions. Map XIV depicts clays and shales.

The occurrence of the mineral fuels, coal and natural gas, in Maryland is confined to the western part of the State. Geological tests in the Coastal Plain have not found any indications of petroleum or natural gas in that region. Mineral fuels information is shown on Map XV.

Miscellaneous mineral deposits as shown on Map XVI include talc and soapstone, high-silica sand, greensand, and diatomaceous earth. Present operations in these materials are small but there is future growth potential.

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Ground-water Aquifers of Maryland

U.S. Department of The Interior - Geological Survey

In Cooperation with the

MARYLAND GEOLOGICAL SURVEY

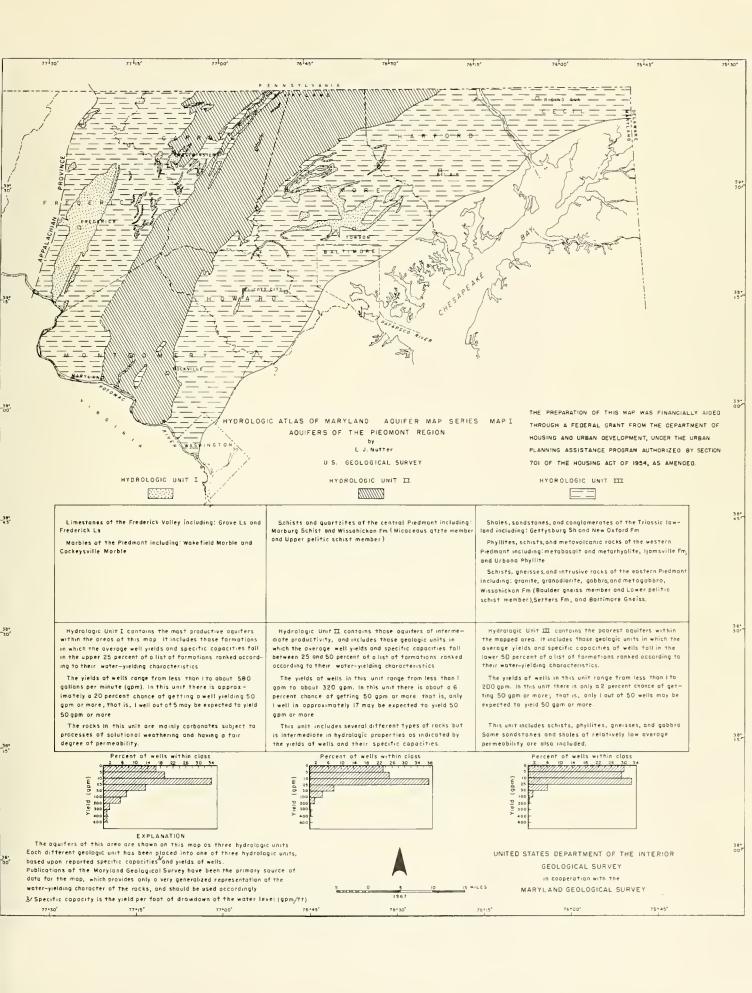


PIEDMONT AND APPALACHIAN REGIONS

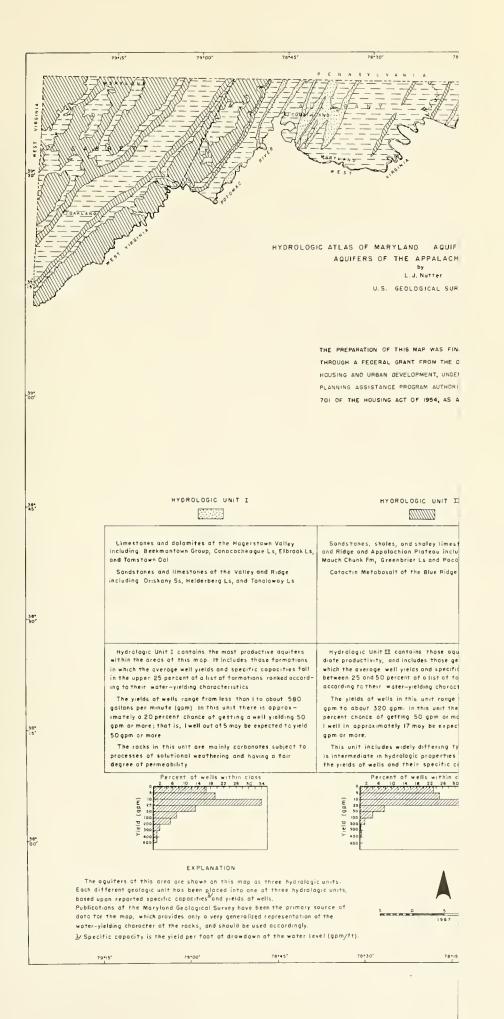
The statistical data presented in Aquifer Map Series I and II were originally compiled for both the Piedmont and Appalachian regions combined. The data were presented on two maps in order to present a more convenient size illustration. The legends on the two maps are identical except that only the geologic units (formations) within each region are included on the map of that region.

It should be emphasized that within any one of the three hydrologic units defined on Aquifer Map Series I and II, extreme variability in yields of individual wells exists. This variability results in part from the fact that factors such as the topographic position of well sites and geologic structure which cause jointing and fracturing in the rocks also determine the amount of water an individual well will yield. The evaluation of specific water supply problems must consider these factors as well as the geologic formation outcropping at a given locality.









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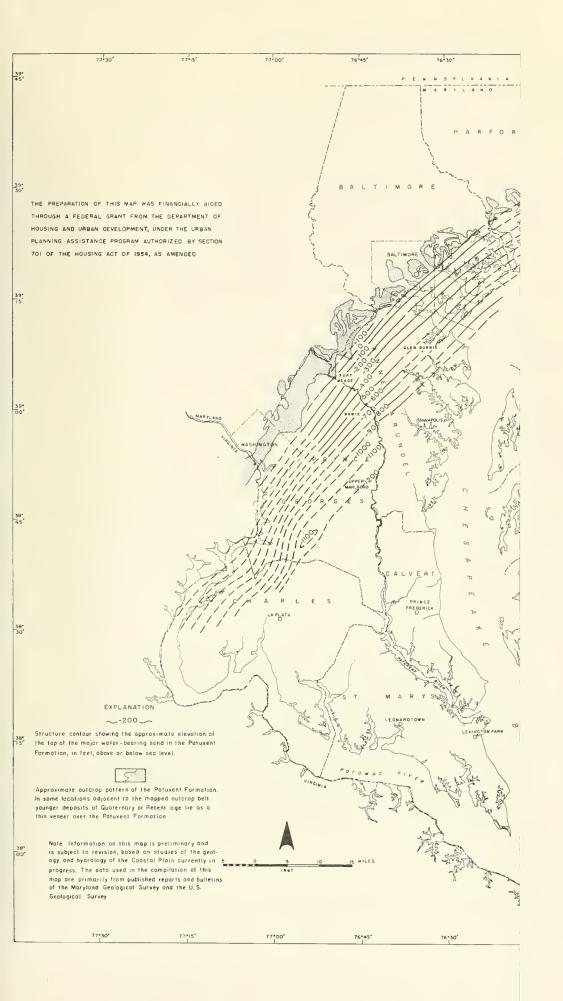
PATUXENT FORMATION

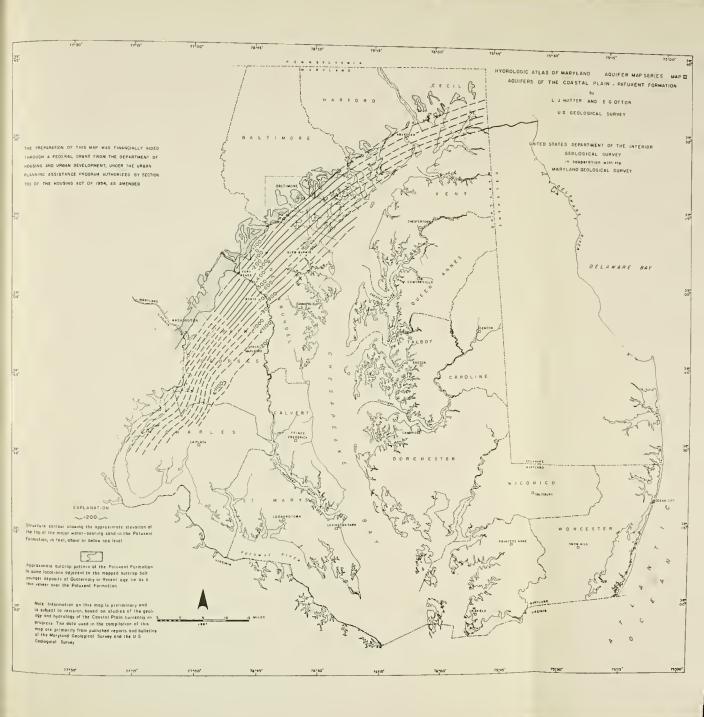
Sands in the Patukent Formation constitute an important source of groundwater along that part of the Coastal Plain immediately southeast of the Fall Zone. The Patukent Formation consists of irregularly stratified layers of sand, gravel, clay, and mixtures thereof. The formation ranges in thickness from a few feet in its outcrop area to as much as 2,300 feet near Ocean City. In Harford, Baltimore, Anne Arundel, and Prince George's counties, where it is most productive, the maximum thickness of the aquifer is seldom more than 350 feet. In the Baltimore area about 50 percent of the total formation thickness is reported to be water-bearing sand and gravel, but the proportion of sand and gravel decreases to the southwest toward Washington, D. C. Yields of wells in the most favorable localities range from a few hundred to as much as 1,200 gallons per minute (gpm).

The Patuxent Formation is a source of groundwater for the towns of Aberdeen, Bowie, Glen Burnie, and some of the suburban communities southeast of Washington, D. C. It furnishes important supplies of cooling water to several industries in and near Baltimore City. The water is commonly soft and of low mineral concentration, but locally it may require treatment for iron removal and/or reduction of acidity.

In many areas of the State, the Patuxent Formation is untapped and may constitute a potential source of large supplies of potable groundwater.







PATAPSCO AND RARITAN FORMATIONS

Formations comprise the most widely used aquifers in the Maryland Coastal

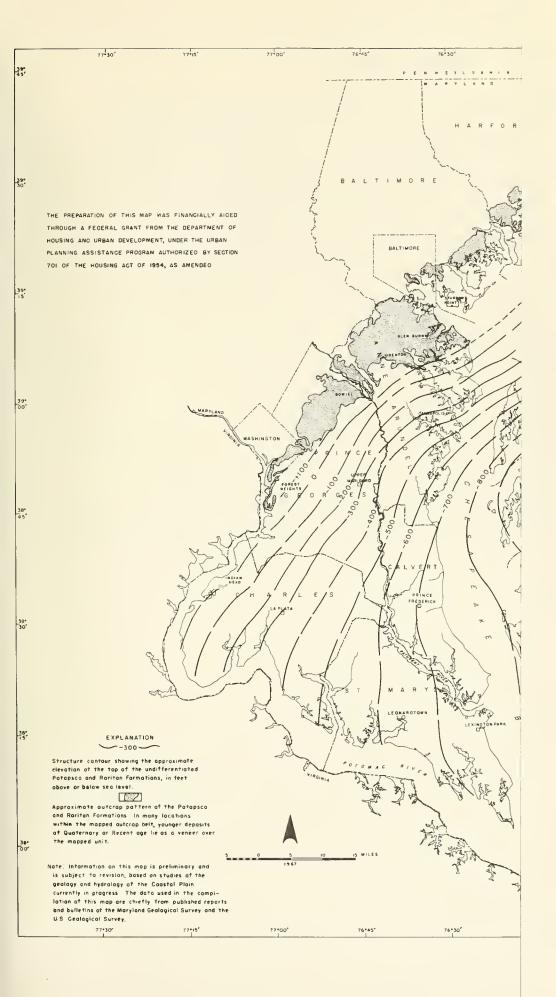
Plain. These formations consist of irregularly stratified layers of variegated
gravel, sand, silt, and clay in varying proportions. Clayer sediments tend to
predominate in the Raritan Formation and sandy sediments are most common in the
Patapsco Formation. The thickness of the combined units ranges from a few feet
in the outcrop area to more than 500 feet near Claiborne. The thickness
probably increases to more than 1,000 feet at Salisbury. At Sparrows Point,
where the formations are approximately 300 feet thick, about one-third of the
strata consist of water-bearing sand and gravel. The proportion of sand
decreases toward the southwest near the Washington, D. C. area. Yields of
wells range from less than 100 to 2,160 gallons per minute (gpm) although wells
yielding more than 1,000 gpm are considered exceptional. The most productive
well is in the Bowie area in Prince Georges County.

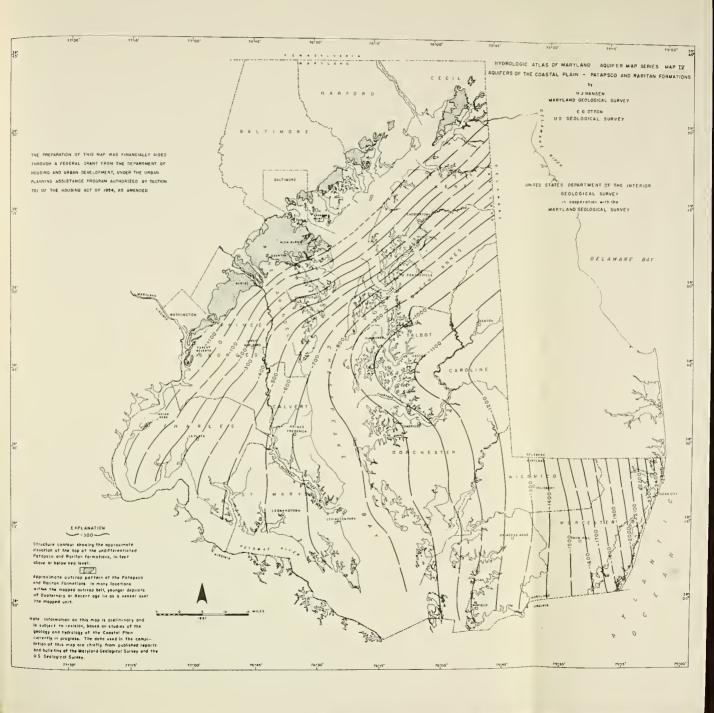
The Patapsco and Raritan Formations are a source of groundwater for the towns of Annapolis, Glen Burnie, Odenton, Forest Heights, Indian Head, and Bowie.

Many industries in the Baltimore area use cooling water obtained from these aquifers. The chemical quality of the water is generally good, but locally treatment for iron removal and de-acidification is required.

Large additional ground-water supplies are available for development from the Patapsco and Raritan Formations. In the northern counties of the Eastern Shore the cost of treatment of the water may be a factor limiting the local use of the aquifers.







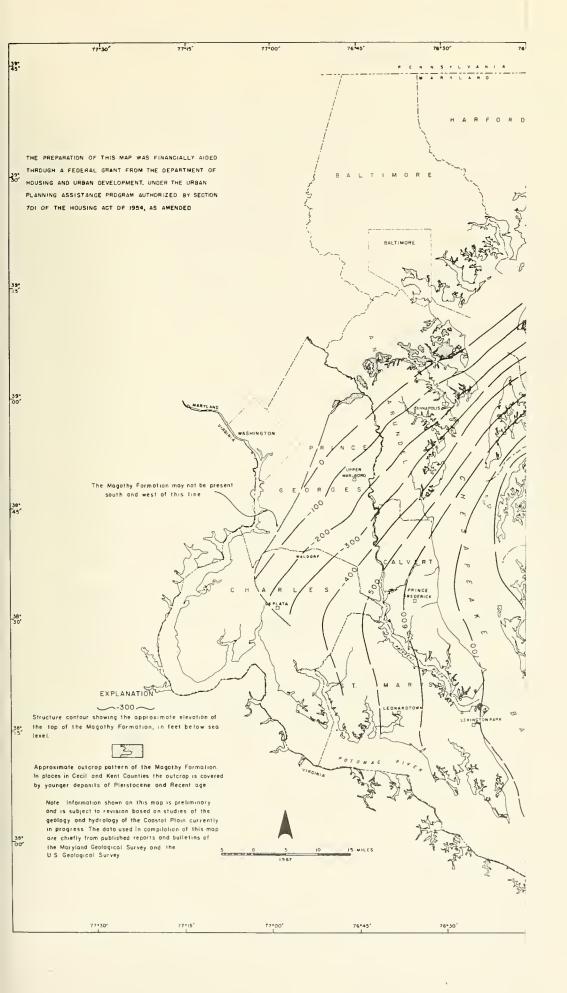
MAGOTHY FORMATION

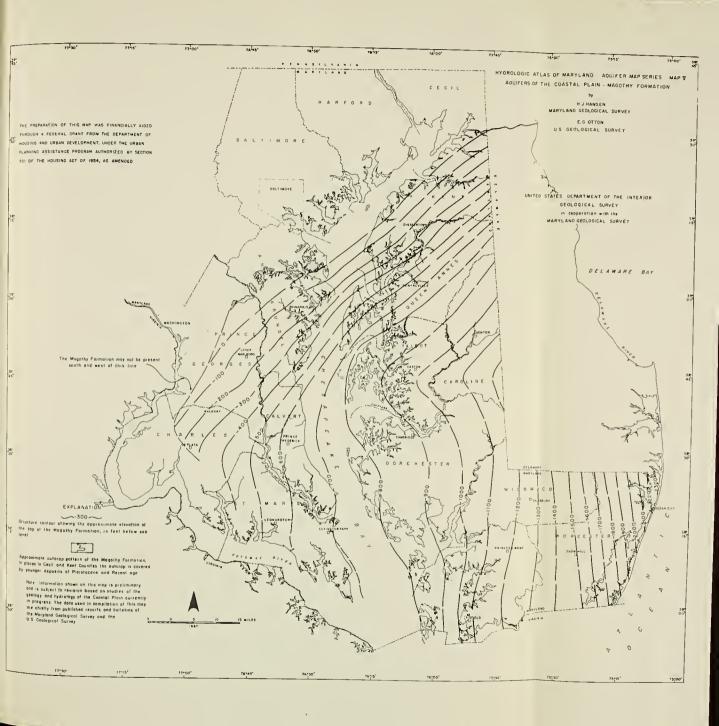
The Magothy Formation is one of the most extensive water-bearing formations (aquifers) in the Coastal Plain of Maryland. The Magothy consists chiefly of beds of sand and gravel with interbedded layers of clay and silty clay. The sands commonly contain fossil wood and, in places, marine shells. The formation ranges from a few feet thick near La Plata to as much as 160 feet thick northeast of Upper Marlboro.

The Magothy supplies water to wells at or near several towns in the State; among these are Upper Marlboro, Waldorf, Easton, Cambridge, and Crisfield. Yields of wells range from a few to several hundreds of gallons a minute. The water is commonly usable for most purposes but locally, as in the Annapolis area, may be acidic and high in iron content.

The aquifer is believed capable of substantial additional development in many areas where it has been tapped by only a few wells or where adequate water supplies have heretofore been obtained from other shallower aquifers.







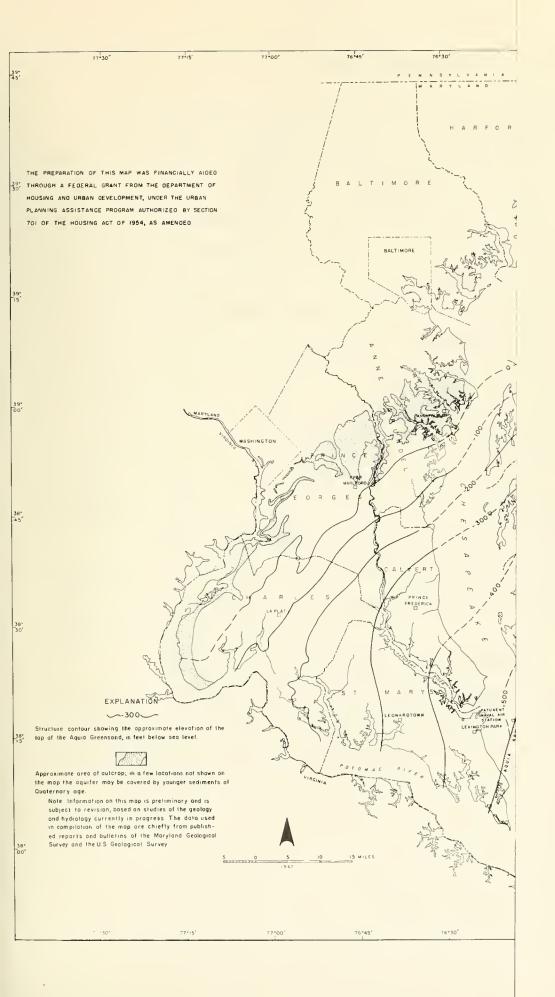
AQUIA GREENSAND

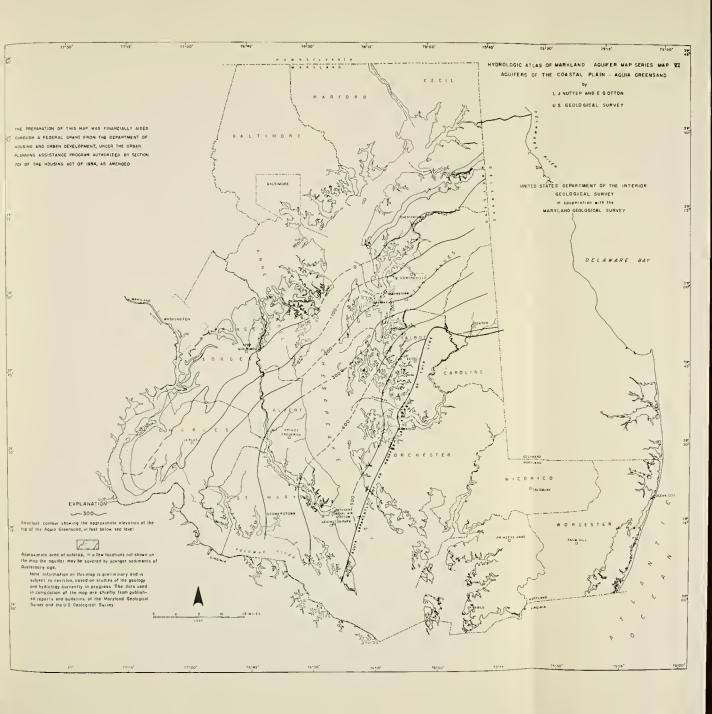
The Aquia Greensand is one of the most important aquifers in the five Southern Maryland counties and in Kent, Queen Anne's, Caroline, Talbot, and Dorchester counties on the Eastern Shore. The Aquia consists of moderately glauconitic quartz sand with a few clay layers and some indurated layers in its middle and basal parts. Its thickness ranges from a few feet along the outcrop belt to as much as 231 feet in Talbot County. Wells producing from the Aquia Greensand have yields ranging from a few to 1,300 gallons per minuts (gpm). The most productive well is for irrigation use and is located in eastern Kent County. A well yielding 350 gpm was tested at the Patuxent Naval Air Station in St. Mary's County where the formation is a primary ground-water source.

The following towns use the Aquia as the major source for their municipal supply: Chestertown, Centreville, Grasonville, Queenstown, and Leonardtown. During recent years the aquifer has become an important source of water for supplemental irrigation on the Eastern Shore. The water is generally of good chemical quality and in many localities is usable with little or no treatment. However, locally treatment for iron removal may be required.

The Aquia Greensand is capable of additional development in many localities in the Coastal Plain.

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PINEY POINT FORMATION

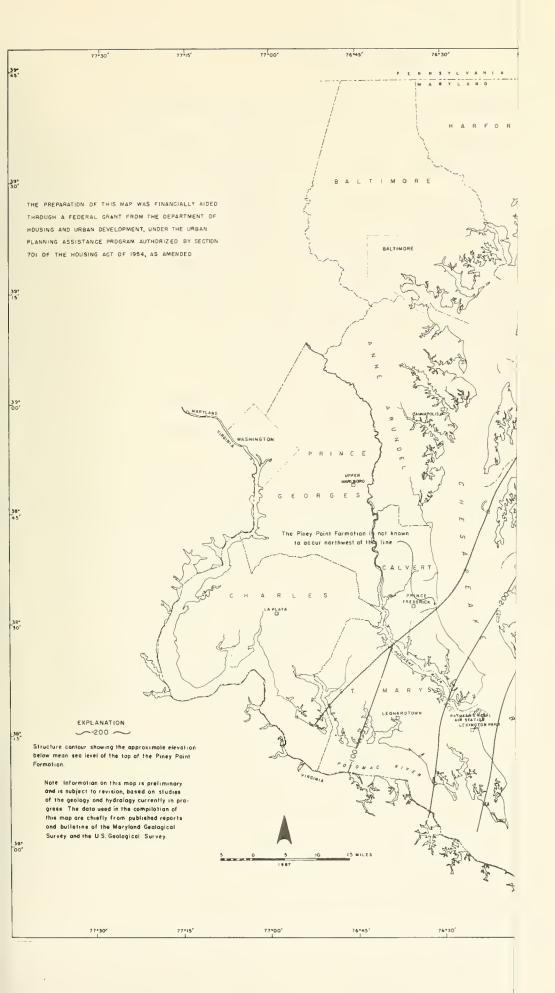
The Piney Point Formation is a major aquifer in Calvert, St. Mary's, Dorchester, Talbot, and Caroline counties, extending southward into Virginia and northeastward into Delaware. The formation consists of glauconitic medium— to coarse—grained sand and interspersed shell beds from 10 feet to more than 100 feet thick, but generally only 50 to 60 feet thick. The Piney Point Formation has no known surface outcrop. The maximum altitude of its known occurrence is about 80 feet below sea level at a point along the lower Patuxent River. Locally the sands of the Piney Point Formation appear to be hydrologically connected with the sands of underlying Nanjemoy Formation, and therefore, the two formations may function as a single aquifer. The yields of wells range from less than 10 to about 1,200 gallons per minute (gpm). The most productive well is a part of the public-supply system of Cambridge, Maryland.

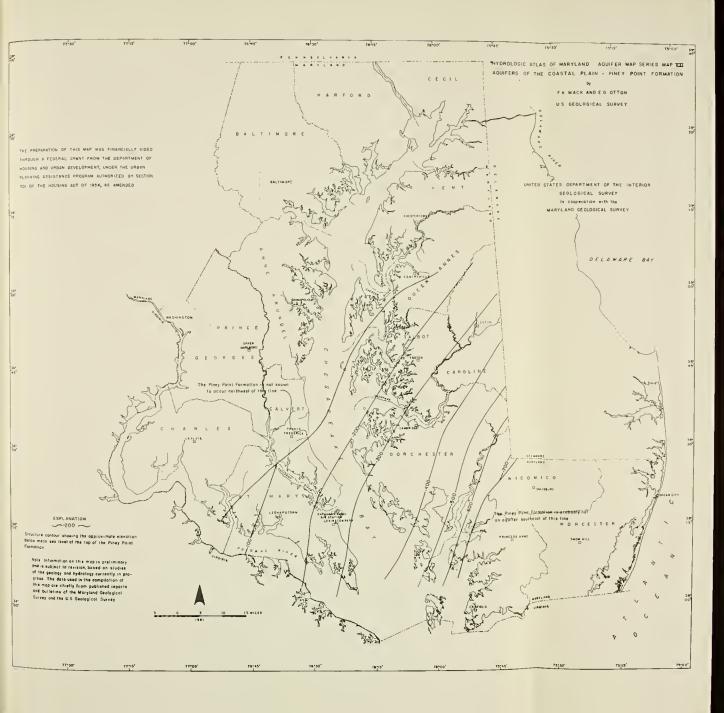
The Piney Point Formation is a source of water for the Patuxent Naval Air Station. It is also tapped by hundreds of domestic wells throughout the area. The chemical quality of the water is good and is relatively uniform.

Water treatment is seldom required.

The apparent limited areal extent of this formation coupled with the limited recharge capability of the aquifer suggest that only moderate development can be expected. More precise definition of the extent and hydrologic character of the aquifer is needed.





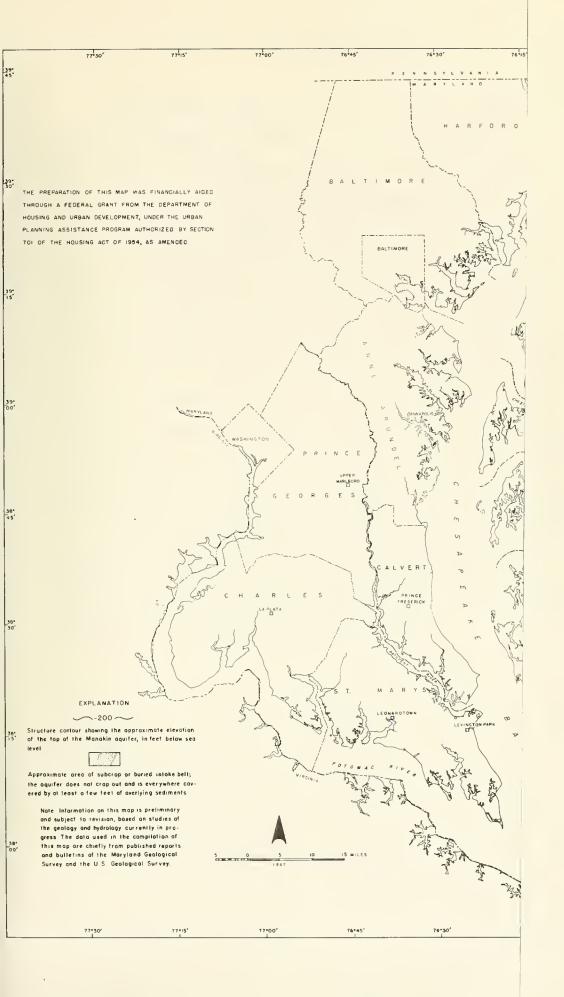


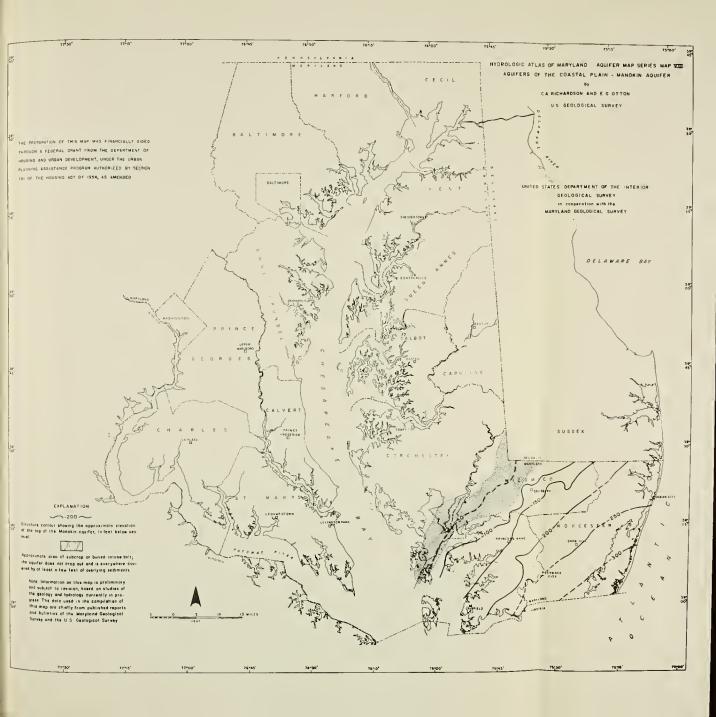
MANOKIN AQUIFER

The Manokin aquifer, a part of the Yorktown Formation, is an important aquifer in Somerset, Wicomico, and Worcester counties. It consists of gray, medium— to fine-grained sand and commonly ranges in thickness from about 90 to 200 feet. In many places the sand is overlain and underlain by silt, and clay, and very fine sand which causes artesian or confining conditions and produces flowing wells in some localities. The yields of the most productive wells tapping the Manokin aquifer range from less than 100 to over 1,000 gallons per minute (gpm), although most public-supply well yields are in the 300 to 400 gpm range.

The Manokin aquifer is a source of water for municipal and/or industrial supplies at Ocean City, Snow Hill, Princess Anne, and Salisbury. It is also used as a ground-water source in the southeastern part of Sussex County, Delaware. The chemical character of the water varies widely within the area. In places, the water may be mildly acidic and/or high in iron content. In other places, such as Pocomoke City and Crisfield, the water contains more than 200 parts per million of chloride.

The Manokin is capable of additional development in some localities, but in others it is not likely to be used because of the undesirable chemical character of the water.





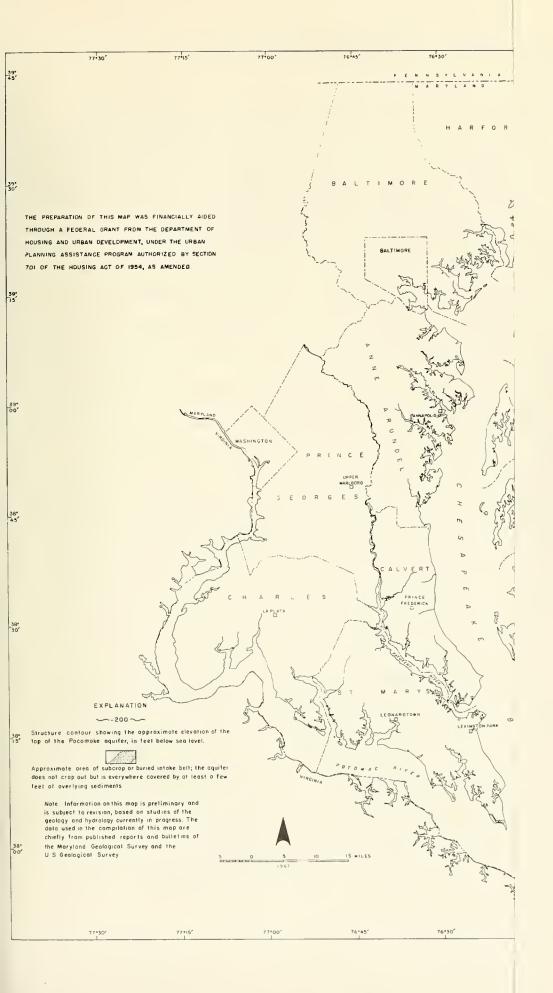
POCOMOKE AQUIFER

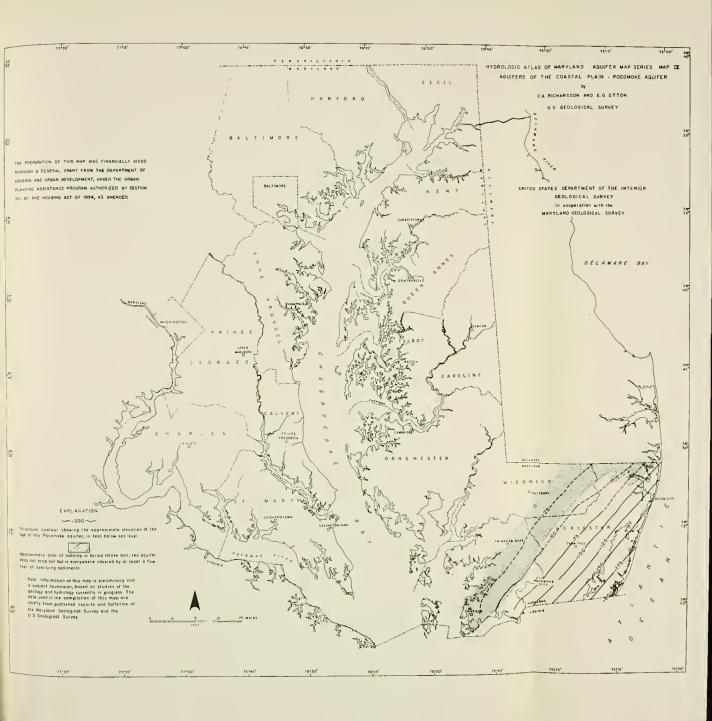
The Pocomoke aquifer, a part of the Yorktown Formation, is a major source of groundwater in Somerset and Worcester counties. It consists of gray, medium— to fine—grained sand with some gravel and thin lenses of clay. In many localities it is overlain and underlain by silt and clay, producing artesian conditions. Southeast of its intake belt the aquifer commonly ranges in thickness from 85 to about 145 feet. The yields of high capacity wells range from about 100 to about 660 gallons per minute (gpm). Generally, wells yielding more than 500 gpm appear to be exceptional.

The Pocomoke aquifer furnishes water for municipal and/or industrial supplies at Pocomoke City, Ocean City, and Crisfield. Locally, iron content of the water is high. The water is moderately soft to moderately hard (hardness range of 60 to 120 parts per million). In places treatment for iron removal may be required for many uses of the water.

The Pocomoke is capable of furnishing large additional supplies of groundwater throughout parts of Somerset and Wicomico counties and nearly all of Worcester County, but its potential may be restricted in some localities by the hazard of salt-water intrusion.







DEPOSITS OF PLICCENE (?) AND PLEISTOCENE AGE

The deposits of Pliocene (?) and Pleistocene age comprise the major aquifer throughout most of the Eastern Shore counties. They are present at present in all of the Eastern Shore counties. The deposits are present at some localities in the Southern Maryland counties, but there they are not an important aquifer. They consist of yellowish to tan and white sand and gravel with some layers of silty clay and clay ranging from a few feet to about 220 feet thick in an area north of Salisbury. Water-table conditions generally prevail throughout the area of their occurrence. The yields of wells tapping the more permeable sand and gravel on the Eastern Shore range as high as 4,000 gallons per minute (gpm), and it is probable that even more productive wells can be constructed in the more favorable localities.

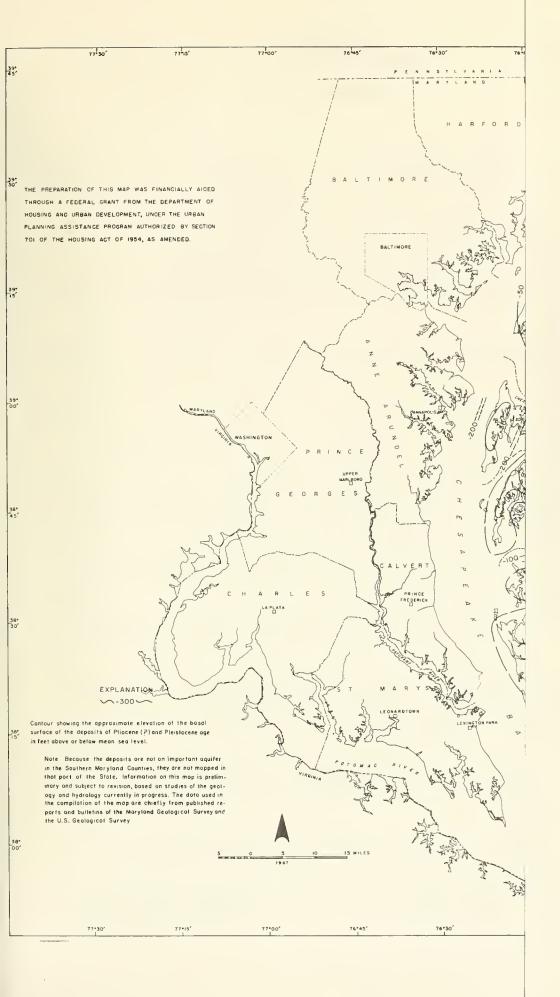
The Pleistocene deposits are the source of water supply for the towns of Salisbury, Berlin, Mardela Springs, Barclay, and for other smaller communities. At Salisbury, supplies of several millions of gallons a day have been developed from these deposits by means of large-diameter wells, 40 to 60 feet deep. Generally, the water is of good chemical quality but locally treatment for iron removal and de-acidification is necessary.

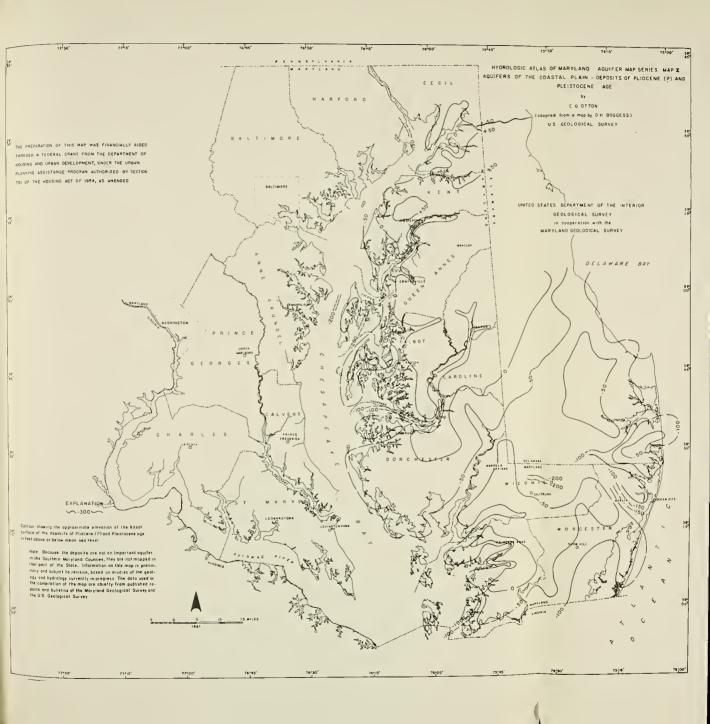
In Queen Anne's, Dorchester, and Wicomico counties individual irrigation wells are known to yield more than one million gallons a day (mgd), but as this use is a seasonal use and is dependent on climatic conditions, it represents no major draft on the aquifer.

The quantity of water available from the Pleistocene deposits is estimated to be many times greater than the current (1966) rates of pumpage from them.

These deposits are potentially the most productive aquifer in Maryland and capable of extensive development.







GROUND-WATER AQUIFERS

OF MARYLAND

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- Note: The Maryland Department of Geology, Mines, and Water Resources was renamed Maryland Geological Survey in 1964.



Mineral Commodities of Maryland

by

Jonathan Edwards, Jr.

MARYLAND GEOLOGICAL SURVEY



Bedrock formations suitable for crushed stone resources are present throughout the Piedmont and Appalachian regions of Maryland. Consolidated rocks suitable for crushed stone do not occur in the Coastal Plain.

Mafic Igneous and Metamorphic Rocks

Mafic igneous (those which have a large proportion of magnesium and iron-bearing minerals) and metamorphic rocks (those of the former which have undergone changes due to natural pressures) are present in the eastern Piedmont from the Pennsylvania state line southwestward to the Potomac River west of Washington, D. C. Such rocks include basalt, gabbro, serpentine, and mafic gneiss. These rocks make aggregate stone of excellent quality because of their toughness, uniformity of texture, and inert chemical nature.

Basalt (diabase) of Triassic age occurs in large tabular masses, called sills, in western Montgomery County and in extreme northern Frederick County. Many small, elongated dikes of basalt also occur in the Piedmont region, but these are usually too small to be of economic importance.

Gabbro and related ultramafic rocks are present in a wide belt from western Cecil County, through central Harford County. to eastern Baltimore County. Large bodies of gabbro also occur in eastern Harford County, and in southern Baltimore and eastern Howard counties. Several small bodies are present in northeastern Cecil County.

Elongated bodies of serpentine occur from the Pennsylvania state line in western Cecil County, across northern Harford County, northern Baltimore County, and central Howard County, to central Montgomery County. Some serpentine occurs with the ultramafic rocks associated with gabbros.

Mafic gneiss occurs in eastern Harford County and in Montgomery County, west of Washington, D. C.



Granitic Igneous and Metamorphic Rocks

Granitic rocks have a composition high in silicic minerals, such as quartz and feldspar, and include granite, granodiorite, diorite, and granitic gneiss. In general, these rocks are coarser-grained than the mafic rocks and contain minerals such as micas and feldspar which cleave easily. Consequently, these rocks do not make as good aggregate stone as do the tougher mafic rocks.

Like the mafic rocks, the granitic rocks occur throughout the eastern Piedmont region from the Delaware state line in Cecil County, southwestward to Montgomery County and Washington, D. C. The largest mass of granitic rocks is the quartz diorite gneiss present throughout Cecil County and extending across Harford County to eastern Baltimore County. Other bodies of quartz diorite occur from eastern Montgomery County to Washington, D. C. Small bodies of granite occur in southern Baltimore County and in eastern Howard County.

Limestone and Dolomite

Limestone and dolomite are bedded sedimentary formations and occur from Frederick County westward to Garrett County. Although these rocks are not as tough as the mafic rocks, they make excellent crushed stone when either thick-bedded or massively-bedded because of the ease of crushing and uniformity of texture and composition.

The largest areas of occurrence are the Frederick Valley of Frederick County and the Hagerstown Valley of Washington County. Smaller areas of limestone are present in western Washington County, in central and western Allegany County, and in four narrow belts across Garrett County. Limestone and dolomite are covered in more detail in the discussion of Carbonate Rocks.



Crystalline Marbles

Like the limestone and dolomite of western Maryland, the marble found in the Piedmont region makes aggregate stone of excellent quality. The Cockeysville Marble is present in western Harford, central Baltimore, and central Howard counties, and in the extreme southeastern corner of Carroll County. In many places the rock contains considerable amounts of mica. The Wakefield Marble occurs in narrow, elongated belts of outcrop from central Carroll County to eastern Frederick County. The Silver Run Limestone also occurs in narrow, elongated belts of outcrop and is present northeast of the Wakefield Marble in northern and central Carroll County. This rock contains a considerable amount of quartz and mica and is more properly called a calcareous schist than a limestone. Because of its schistose texture, the Silver Run Limestone may prove to be unsuitable for crushed stone. Crystalline marbles are discussed in more detail under Carbonate Rocks.

SUMMARY

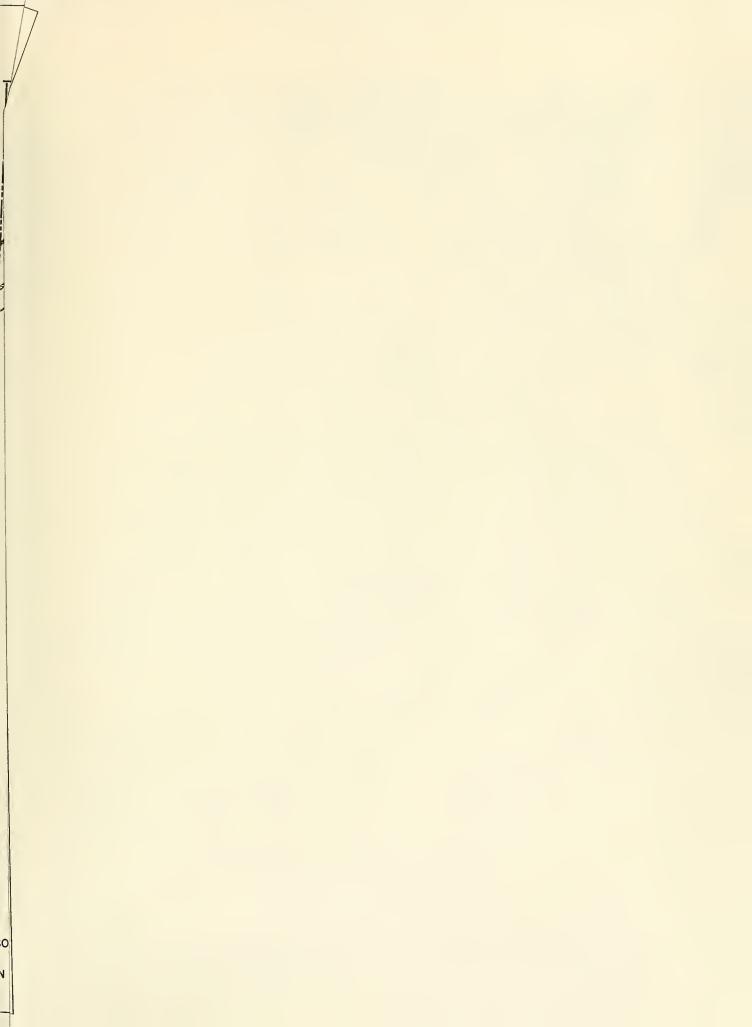
Quartzites and quartzitic sandstones (not shown on map) which occur from Carroll County westward to Allegany County are not currently used for general purpose aggregates because of the relatively high processing cost.

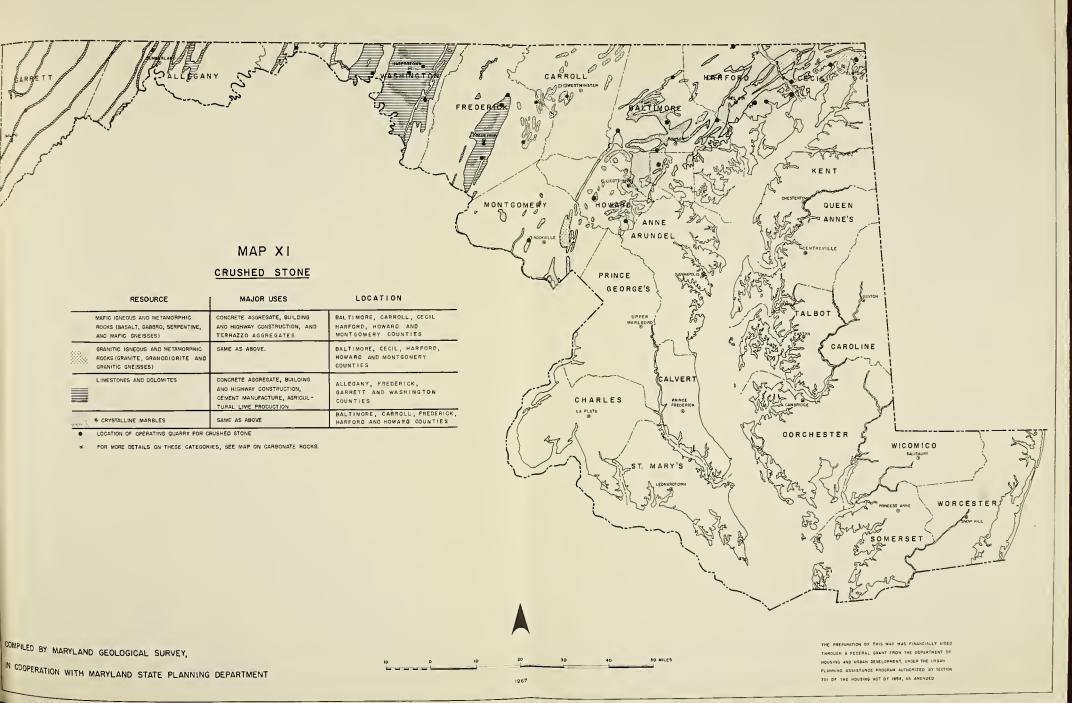
These rocks are used primarily in applications where the chemical or physical properties are important, such as in the glass industry or for refractory products. These uses are covered under Miscellaneous Mineral Deposits.

At the present time, the economically most important sources of crushed stone are the mafic rocks and the crystalline marbles in the eastern Piedmont near the large metropolitan centers of Baltimore and Washington, D. C. The Frederick Valley limestones will become increasingly important as the Washington, D. C. metropolitan area expands toward Frederick. Other important

areas are limestones in Allegany County near Cumberland. In the future, the sources of crushed stone underlying land not preempted by suburban development near Baltimore and Washington, D.C. will increase in importance, as will mafic rocks in Harford and Cecil counties which are in the developing corridor between Philadelphia and Baltimore. The granitic rocks in this latter area will probably increase in importance as well.











The Cockeysville Marble crops out in a large area of central Baltimore County, and also in smaller areas in Carroll, Harford, and Howard counties.

This rock ranges in composition from a pure calcite marble to a dolomite marble, and in many places it contains much mica. The major use for the rock is crushed stone, but the pure calcite marble is used for roofing granules and white aggregate, and in a finely-ground form, as white mineral filler and agricultural limestone. Some types may be pure enough for chemical use. Production of the Cockeysville Marble in the future very likely will be limited to the areas presently being worked, in that the area of occurrence of this formation is close to the Baltimore metropolitan area and is rapidly becoming covered with suburban development.

Limestone formations which are being extracted at the present time for crushed stone are found in the three western Maryland counties of Allegany, Garrett, and Washington. The Greenbrier Limestone occurs in narrow belts of outcrop which extend across Garrett and western Allegany counties. The Helderberg, Keyser, and Tonoloway Limestones occur together in several similar belts from central Washington County to western Allegany County. The Chambersburg, New Market, Row Park, and Rockdale Run Limestones all occur in the Hagerstown Valley of Washington County. These formations are in the region of folded rocks in the Appalachian Mountains and are comprised of moderately- to steeply-dipping beds. It is possible that in some localities any one of these formations may be of sufficient quality for use in cement or agricultural lime manufacture, or as chemical grade stone.

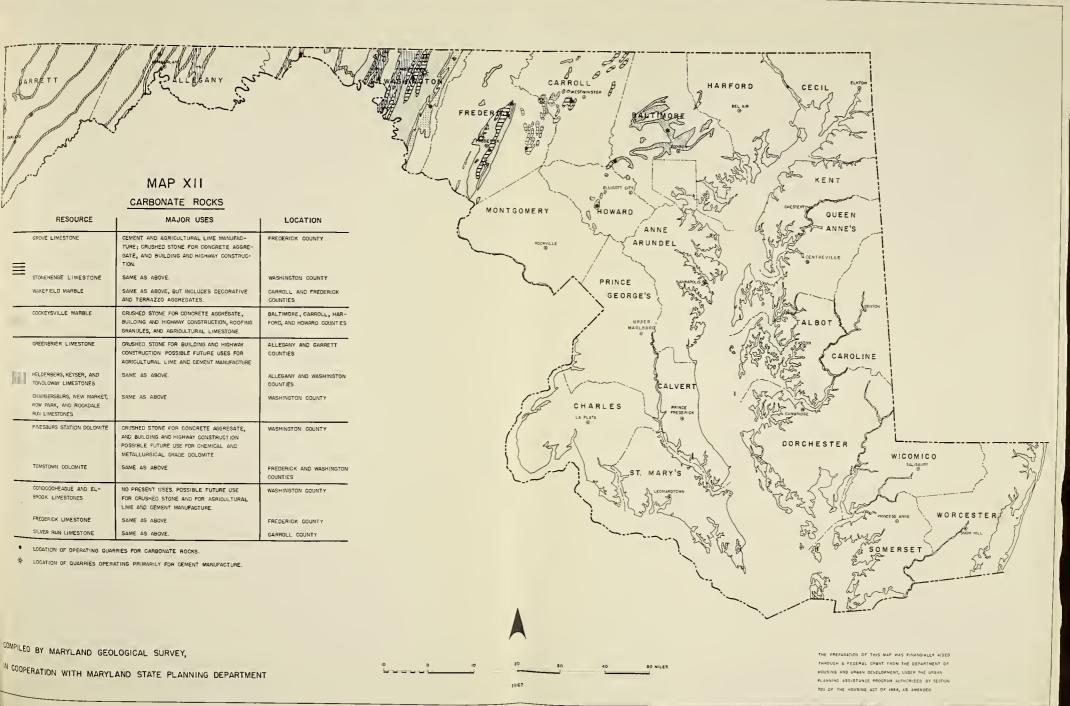
The Pinesburg Station Dolomite, present in the Hagerstown Valley portion of Washington County, and the Tomstown Dolomite in eastern Washington County, are also used at the present time as crushed stone. Two small areas of outcrop of the Tomstown Dolomite are also present in Frederick County, southwest



of Frederick. It is possible that in some localities these dolomite formations in Washington and Frederick counties may have a purity suitable for chemical or metallurgical grade dolomite.

Carbonate rocks not utilized at present include the Conococheague and Elbrook Limestones in Washington County, the Frederick Limestone in Frederick County, and the Silver Run Limestone in Carroll County. These formations are in general too thin-bedded or too schistose for use as crushed stone or else their chemical composition renders them unsuitable for sources of lime or cement. It is possible that locally some of these rocks may be of better quality, but it is unlikely that they will be utilized so long as better sources of stone exist.





SAND AND GRAVEL

Sand and gravel in economically extractable deposits occur throughout most of the Coastal Plain in eastern Maryland. In the remainder of the State, sand and gravel deposits are limited to terrace deposits and local alluvial deposits in the flood plains of the larger streams which drain the area.

Sand of Pleistocene to Recent age in the Eastern Shore region occurs as a blanket deposit which has an average thickness of between 35 and 60 feet. Some clay and silt occur with the sand, and very minor amounts of gravel occur as well. In the Western Shore region, gravel and sand of Pleistocene to Recent age occur as depositional terraces flanking the larger streams. These terrace deposits are particularly well-developed along the Patuxent River where the maximum thickness is 60 feet. Here, the coarser gravel occurs near the western edge of the Coastal Plain, and the grain size decreases in a downstream direction where only sand is present. Deposits of sand and gravel of Recent age are dredged from several of the larger streams in the Eastern Shore and Western Shore regions.

The upland gravel of Plio-Pleistocene age, known as the Brandywine Formation, occurs as a blanket deposit which covers the plateau-like upland surface of Charles, St. Mary's, southern Prince George's, and southern Calvert counties. The formation is from 30 to 60 feet thick. Sand makes up most of the formation, and interstitial clay with iron oxide acts as a cementing agent in parts of the deposit. Lenses of gravel are commonly coarse in Prince George's County, but these decrease both in average grain size and in frequency of occurrence toward the southeast. This gravel has been weathered, but its quality should not be affected for general construction use.

Lenses of sand and gravel of Cretaceous age occur within a broad belt of outcrop which extends from near Elkton, Cecil County, southwestward through Baltimore to Washington, D. C. Generally, sand occurs toward the southeastern



margin of the outcrop belt whereas the gravel lies along the northwestern margin. In many places the best gravel deposits occur along the extreme northwestern edge.

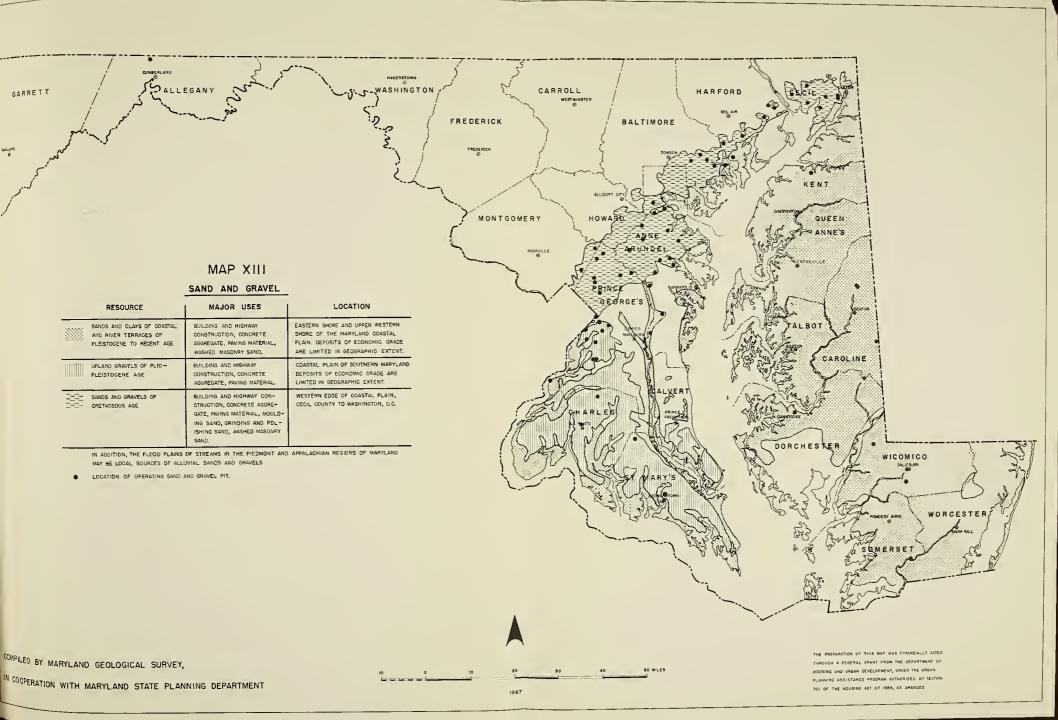
At the present time the economically most important sand and gravel deposits in the State are the Cretaceous deposits in the vicinity of Baltimore and Washington, D. C. Less important are the Pleistocene terraces along the Patuxent River and the deposits located in the Brandywine Formation of Prince George's County. In the future, however, the encroachment of the Baltimore-Washington, D. C. metropolitan complex will preempt the belt of Cretaceous sediments with suburban development unless areas are preserved for mineral extraction by public land use controls. The sand and gravel deposits of the Brandywine Formation will become of prime importance in the future. The river terraces of Pleistocene age along the Potomac River as well as those along the Patuxent River will continue to be important sources of sand and gravel.

Cretaceous deposits of sand and gravel in Harford and Cecil counties will increase in importance with the growth of the Baltimore and the Wilmington (Delaware) metropolitan areas.

Present knowledge indicates that gravel deposits of the Eastern Shore region are not as significant as those of the Western Shore Coastal Plain since they occur as thin lenses within the overall blanket of sand. Further exploration for gravel deposits will be needed to meet the increasing demand for construction materials as the Eastern Shore develops.







CLAYS AND SHALES

Clays and shales occur throughout Maryland. They have been classified on the accompanying map on the basis of the economic importance of present and potential uses.

Brick clay is found throughout the eastern part of the State and as far west as Washington County. Clay lenses occur as widely-separated bodies within the blanket of Pleistocene sand on the Eastern Shore. The New Oxford Formation and Gettysburg Shale, which occur in Carroll, Frederick, and Montgomery counties also may be used for the manufacture of terra cotta pipe and tile products. Although weathered shale is most desirable from the standpoint of ease of extraction, unweathered material also is suitable for use. A considerable number of sandstone beds are present within the New Oxford Formation, but the Gettysburg Shale in northern Frederick County contains relatively few interbedded sandstones. In Washington County, the weathered Martinsburg Shale long has been used for brick manufacture. The unweathered shale serves as a raw material in the manufacture of Portland cement and also may be suitable for lightweight aggregate.

Clay bodies of Cretaceous age occur as lenses in the Potomac

Group, which crops out from near Elkton, Cecil County, to Washington, D. C.

These clay lenses have a wide range in quality which determines whether they

may be used best for the manufacture of building brick, fire brick, refractories,

or terra-cotta pipe and tile products.

Fire clay which occurs as bedded deposits within the coal basins of western Maryland is used for fire brick and other refractory products. The most extensive bodies of fire clay are found with the Pottsville Formation. Other shale formations within the coal basins may have future value in the manufacture of brick or lightweight aggregate.



A dark gray shale unit occurs within the Frederick Limestone in Frederick County and is used by a plant at Woodsboro for the manufacture of lightweight aggregate. Due to repetition by folding, the shale is present in 5 steeply-dipping belts of outcrop along the eastern side of the Frederick Valley.

Clay and shale formations not utilized at the present time are the St. Mary's Formation, the Marlboro Clay Member of the Nanjemoy Formation, the Rockwell Shale Member of the Pocono Formation, shales of Devonian age in western Maryland, and the Peach Bottom Slate.

The St. Mary's Formation in southern Calvert and St. Mary's counties has potential use in the manufacture of lightweight aggregate. The overburden of Pliocene and Pleistocene deposits is not too thick to preclude profitable extraction on the Western Shore. However, on the Eastern Shore Pleistocene sediments are much thicker, and where the St. Mary's Formation is present in the subsurface it is below sea level.

The Marlboro Clay Member of the Nanjemoy Formation, outcropping in Anne Arundel, Prince George's, and northern Charles counties, has possibilities for use in the manufacture of brick and terra cotta products. Commercial use will be limited to the area of outcrop, as the thickness of overburden is too great to be economically removed. The clay dips gently to the southeast.

The Rockwell Shale Member of the Pocono Formation crops cut on the top of Town Hill in Allegany County and along the top of Sideling Hill in Washington County, and may possibly be used in the manufacture of lightweight aggregate. However, its rather remote location may place it at an economic disadvantage to other sources of lightweight aggregate.

Shales of Devonian age occur throughout a large area of western Maryland from central Washington County to western Allegany County. These shales may have a future use in brick manufacture, particularly where they have been weathered. The shales are interbedded with sandstone and siltstone, and they have been folded throughout the area of occurrence. The fact that these formations are located rather far from large population centers may preclude their use for some time.

The Peach Bottom Slate in northern Harford County has been used in the past for roofing slate and is suitable for the production of roofing granules. The weathered slate may be usable for lightweight aggregate, but results of firing tests have not been very encouraging.

In addition to these clay and shale units, localized deposits of residual clay have been utilized in the past for brick manufacture in central and western Maryland. These clay deposits overlie marble or limestone bedrock.

and shale in Maryland are the clay deposits of Cretaceous age near the
Baltimore and Washington, D. C. metropolitan areas. However, as these metropolitan areas expand, the surrounding land areas will be preempted by suburban
development unless mineral deposits are preserved by public land use controls.

Clay and shale formations which will increase in importance as metropolitan
areas expand are; the New Oxford Formation and Gettysburg Shale in Carroll,

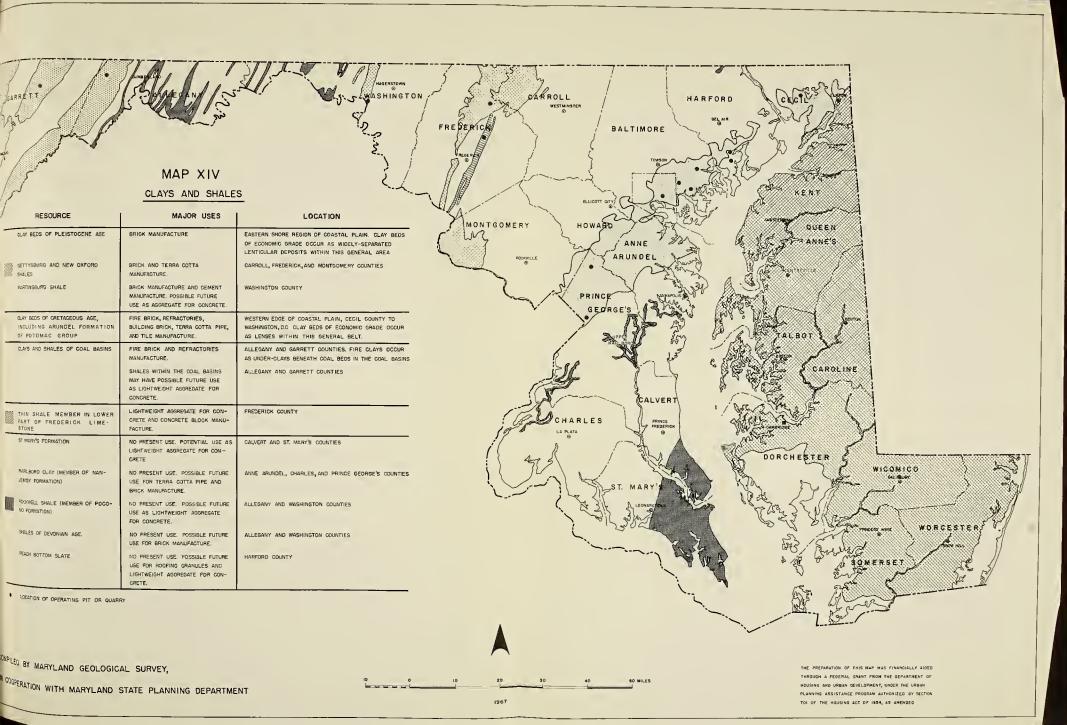
Frederick, and Montgomery counties, and the Marlboro Clay in Anne Arundel,

Prince George's, and Charles counties. Development of the Eastern Shore
region will require further exploration to locate additional deposits of

Pleistocene clay. The Martinsburg Formation, in Washington County, and
shales of Devonian age may increase in economic importance with future
development of the western Maryland counties.







MINERAL FUELS

Mineral fuels produced in Maryland are natural gas and coal, both of which occur in the western part of the State. No oil has been found in Maryland, although three deep test wells have been drilled on the Eastern Shore, with no oil or gas shows recorded.

Natural gas occurs in Garrett and Allegany counties, but at the present time only one field (the Mountain Lake Park field in southern Garrett County) is producing. The recently discovered Negro Mountain field in northern Garrett County currently is being developed for production. The Green Ridge field in northeastern Allegany County is an extension of a producing field in southern Bedford County, Pennsylvania.

The Accident field in northwestern Garrett County was formerly a producing gas field, but it is being converted into a gas storage field. A buried structure near Brandywine in southern Prince George's County has been proposed for use as a gas storage field for the Washington, D. C. metropolitan area.

Areas of Maryland in which natural gas may be found in the future include Washington County west of the Bear Pond Mountains and virtually all of Allegany and Garrett counties. This is the general area of occurrence of the Oriskany Sandstone, which is the reservoir rock for all existing natural gas fields in the State.

Coal is present in Garrett and western Allegany counties, in five elongated, trough-shaped basins known as the George's Creek, Upper Potomac, Castleman, Lower Youghiogheny, and Upper Youghiogheny basins. The greatest number of workable coal seams are in the George's Creek basin, but many of the better seams have been mined out. Workable coal seams are those seams which have a thickness



greater than 28 inches, and which have a low percentage of ash and a high heat generating characteristic. Current recoverable reserves are as follows:*

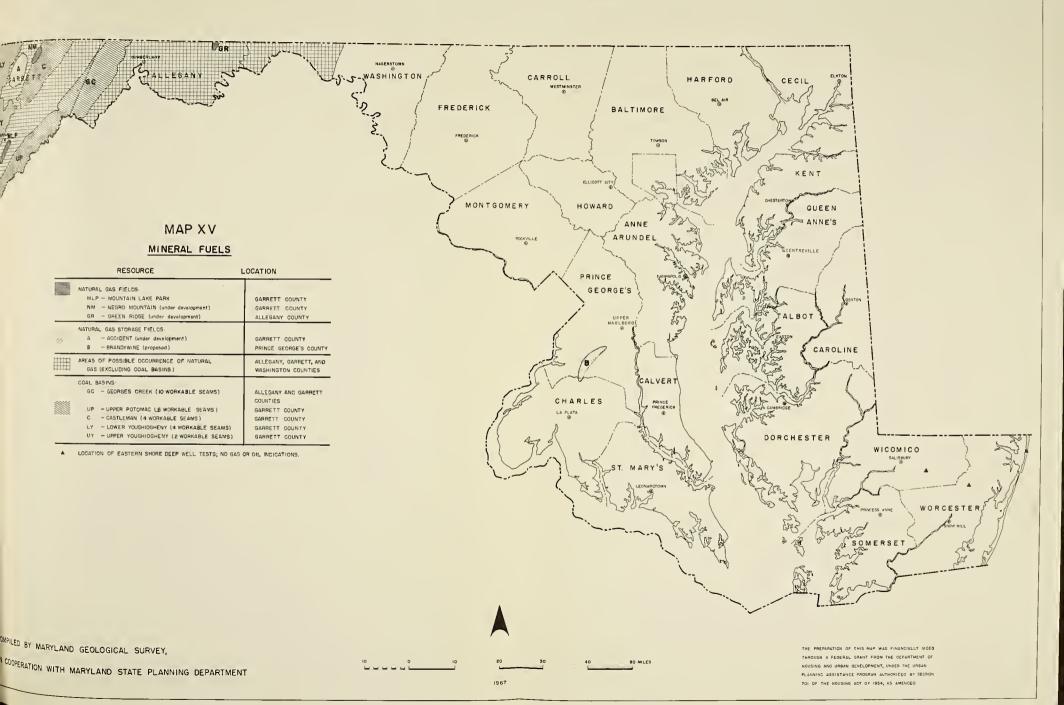
Coal Basin	Deep Tons	Strip Tons
George's Creek Upper Potomac Castleman Lower Youghlogheny** Upper Youghlogheny**	247,821,265 170,889,331 38,038,487 23,300 acres 23,300 acres	20,464,718 12,768,228 5,924,670 1,640 acres 1,640 acres

Peak production of coal in Maryland occurred in 1907 when 5,632,628 tons were mined. The lowest volume of production since 1907 was LLL,895 tons in 1954. Since 1963, the volume of production has exceeded 1,000,000 tons per year. In 1965, production of coal in Maryland was 1,195,787 tons. Strip-mined coal accounted for 63 percent of this total. More stringent Federal and State laws governing strip mining and reclamation methods may render strip mining unprofitable in some areas of the coal basins. Future economic conditions or technology may make it feasible to mine coal seams which at the present time are considered too thin or of too poor quality to be economically workable.

^{*} Data from Boyd report (see Selected References).

^{**} No data available for these basins on which to base calculations for reserves tonnages.





MISCELLANEOUS MINERAL DEPOSITS

The miscellaneous mineral deposits represent only a very small proportion of the total value of mineral production in Maryland. Some minerals included in this category are not produced at the present time, but possibilities exist for future production.

Talc and Soapstone

Talc and soapstone occur as small discontinuous masses within the serpentine bodies which extend across the Piedmont region from the Pennsylvania State Line in northern Cecil County southwestward to central Montgomery County. Future production of these materials is not expected to increase significantly over that of the present. The two current operations are located at Dublin, Harford County, and at Marriottsville, Carroll County.

High-Silica Sand

The Tuscarora Sandstone is quarried at Cumberland, Allegany County, primarily for use as glass sand, but a portion of the production is utilized as construction sand and for the manufacture of ferrosilicon. The Oriskany Sandstone, although not quarried for glass sand in Maryland, is productive in adjacent states. These two sandstone formations are exposed along the crests or flanks of ridges from central Washington County to western Allegany County. In Maryland, outcrops of the Oriskany Sandstone are more numerous than those of the Tuscarora Sandstone.

The Raritan Formation in the upper part of the Potomac Group is present in the Coastal Plain of Maryland from Cecil County to the Potomac River in Prince George's County. However, at the present time the Raritan Formation is known to attain a quality pure enough for glass sand only in Anne Arundel County.



The Pottsville Formation occurs in the coal basins of Allegany and Garrett counties and contains quartzose sandstone and conglomerate in the lower part of the formation which may be of a quality suitable for products requiring high-silica sand.

In the future, it is probable that the importance of the Oriskany

Sandstone for glass sand will increase. It is also possible that the Pottsville

Formation will increase in importance because of its proximity to the large

centers of glass manufacture in West Virginia and Pennsylvania. The Raritan

Formation in eastern Maryland may become important as a source of sand for

glass or other products requiring high purity sand.

Greensand

Greensand, composed primarily of the mineral glauconite, occurs in the Aquia and Nanjemoy Formations which crop out in a broad belt from Kent County to Charles County. At present, Maryland greensand is used as a soil conditioner. Glauconite is mined in New Jersey for use as a water softener. At some future time, glauconite may serve as a source of potash if economical methods are developed for its extraction.

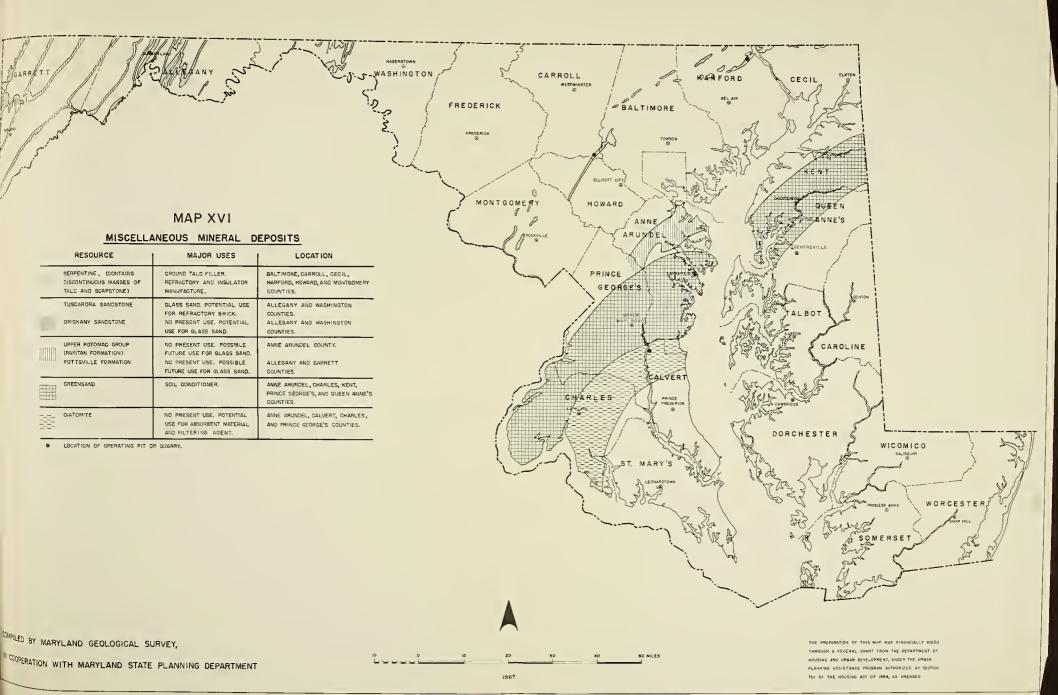
Diatomite

Diatomite occurs as a 20-foot thick bed in the basal Calvert Formation in Calvert, Prince George's, and Charles counties. As the formation dips to the southeast, the thickness of overburden in that direction becomes too great to be removed economically. Diatomite can be used as a filtering agent, as an absorbent material, or as a mineral filler.

At present, most domestic diatomite comes from the West Coast, primarily from California. Lesser amounts are produced from Nevada, Washington, Arizona, and Oregon. There is no production from the Maryland deposits. Maryland diatomite contains more clay than the western deposits, but considering the







cost of transport from the West Coast, it may be possible that the cost of processing the Maryland diatomite would be sufficiently low to make it competitive for eastern markets.



MINERAL COMMODITIES OF MARYLAND

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- Note: The Maryland Department of Geology, Mines, and Water Resources was renamed Maryland Geological Survey in 1964.



